

# Modeling Cognitive Processes for C<sup>4</sup>ISR and IW

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# Why Model Cognitive Processes?

- Account for the human element
- ➔ Simulation outcome should reflect commander's influence
- ➔ Commander's influence on outcome determined by his decisions
- ➔ Need to simulate decision making behavior
- ➔ Cognitive process models are a means to the end of simulating behavior

# Modeling Decision Making Behavior: Two Approaches

## ■ Process models

- Detailed models of human information processing
- Decisions emerge from the process

## ■ Commonly used in research on human problem solving

## ■ Normative + Error

- Models how and when behavior deviates from normative solution
- Possible decisions are enumerated first

## ■ Commonly used for research on judgment & decision making

# Conclusions

- It is possible to simulate C<sup>2</sup> decision making behavior without simulating human decision making processes
- It is also preferable
  - Simulations should be able to generate doctrinally correct and reasonable intelligence assessments and plans (i.e., normative judgments and decisions)
  - ⇒ Only need to model the “+ error”

# Simulating C<sup>2</sup> Decision Making Behavior: Adversarial Planner

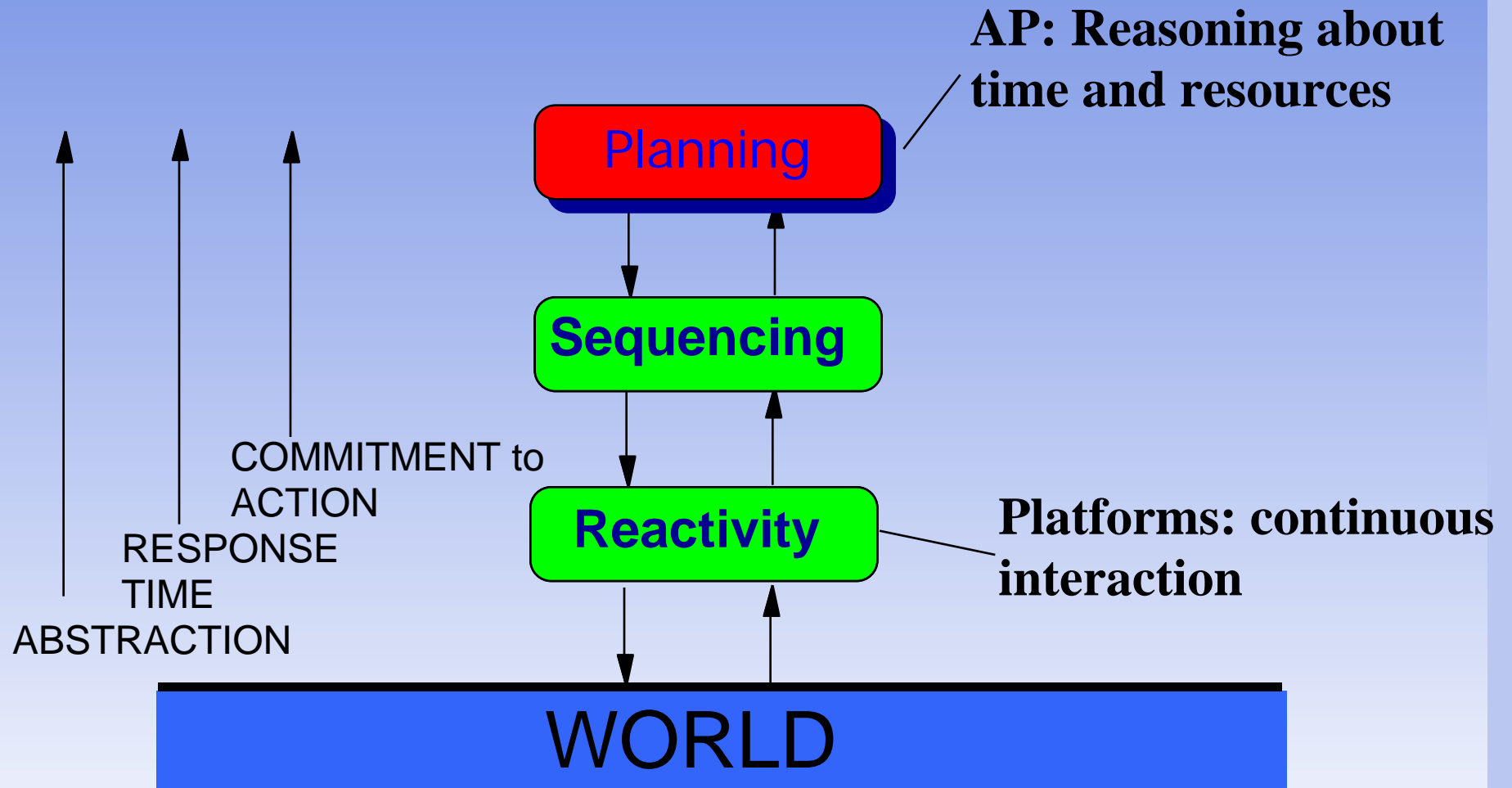
## ■ Functionality

- Multi-agent planning
- Counterplanning
- Execution monitoring
- Replanning *when* (not *if*) things go awry

## ■ Uses

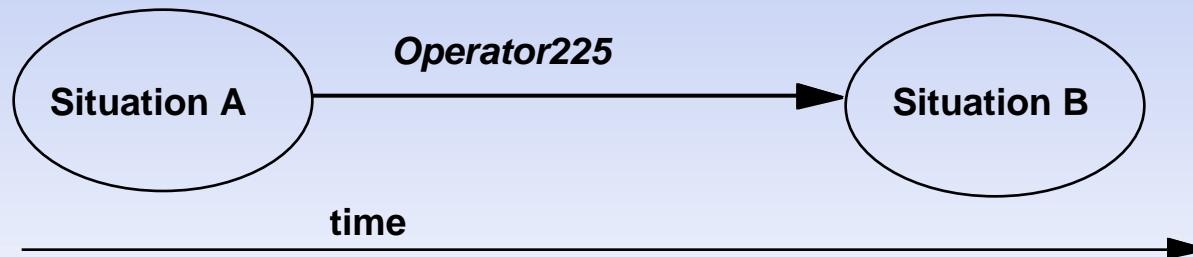
- Simulating one level of command
- Decision aids

# Level of Decision Representation

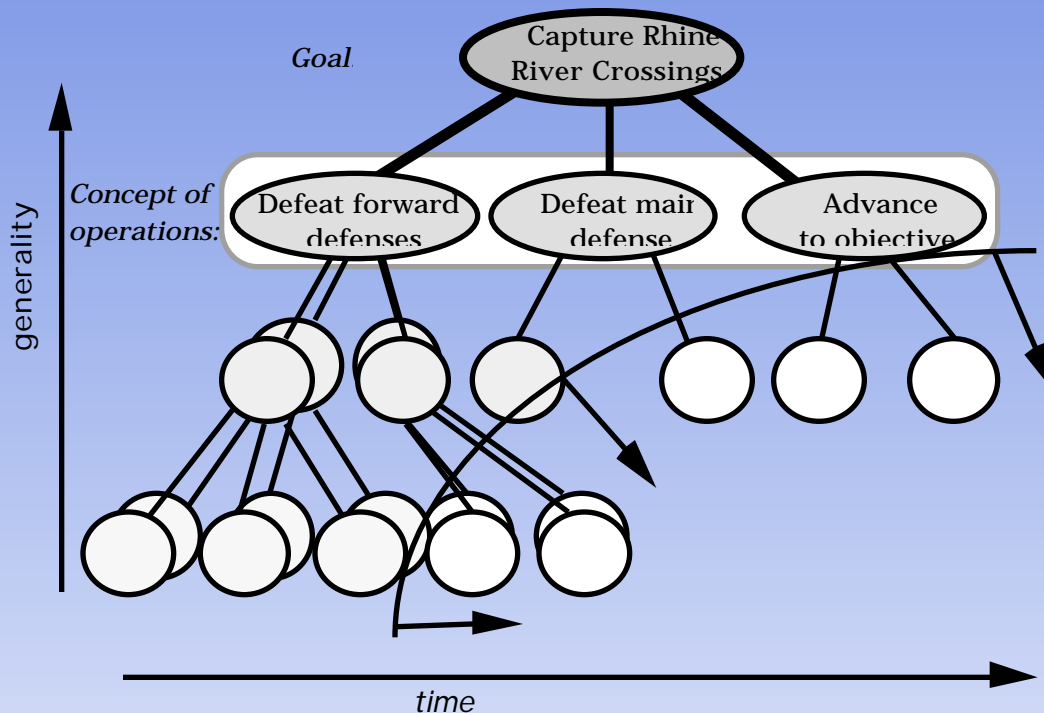


# Representing Battle State

- Perception of the world stated as propositional fluents:  
(holds (in-range ?agent ?objective) <situation>)
- States represented by a sets of propositions
- Operators change some propositions, resulting in a new *predicted* situation



# Representing a Friendly Plan



- Task Decomposition planning
- Leaves correspond to orders to subordinates

**Start executing when there is not enough information to plan later phases in detail**



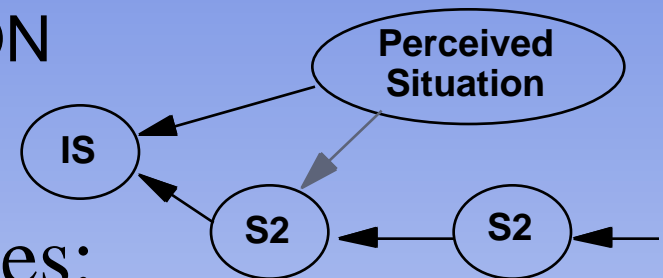
# Counterplanning: Representing Enemy Objectives

- Generate friendly initial plan
- Hypothesize enemy plans that could *prevent* successful execution
- Incorporate plan fragments that fit with current plan and *prevent* enemy's counterplan

In effect, enumerates reasonable options for both sides

# Execution Monitoring: Assessing Current & Future Status

- Update PERCEIVED-SITUATION with reports from agents
- When an operation completes:
  - Project effects through future situations
  - Check if OK to start pending operations
- Trigger replanning when current action does, or future action is predicted to fail



# Dynamic Decision Making

- Dynamic, uncertain domains require capability for plan repair
  - To achieve the original goal by alternate means
  - Without changing the plan so drastically as to waste preparations (maintain momentum)

“Yes, [war is] choreographed, and what happens is the orchestra starts playing and some son of a bitch climbs out of the orchestra pit with a bayonet and starts chasing you around the stage. And the choreography goes right out the window.”

- Norman Schwarzkopf

# An Instantiation for Information Warfare

- AP generates alternative COAs
- Plan evaluation --> Probability of success for each plan
  - Normative, based on what we plan to do
  - Identify information from state description necessary to assess particular probabilities
- Error sources
  - Missing or distorted information
  - Cognitive biases

# Modeling Information Error

- Go from info used to assess true probability of success to incorrect assessment (by enemy) of perceived probability of success
  - Delay
  - Distort
  - False info
- Can model effects on information without modeling cognitive errors, biases, etc.

# Modeling Cognitive Error

- Initial judgment: Broken leg cue
  - Overvalue “telling indicators”
  - Plan observable event normally associated with (wrong) COA
- Delaying replanning: Confirmation bias
  - Information counter to previous assessment devalued
  - Information confirming previous assessment overvalued

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